



The SATA Universal Storage Module (USM) Standard: Ushering in a New Age for Portable Storage

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Revision 3.1 of the SATA specification introduces a variety of performance improvements, reliability enhancements, and new features to expand the functionality and convenience of SATA-based storage devices. In addition to providing new power management capabilities and mechanisms to maximize device efficiency, Revision 3.1 also includes the SATA Universal Storage Module (USM) specification for implementing removal and expandable portable storage applications.

The USM specification is the first standard to define a cartridge slot capable of accepting a complete, powered external hard disk storage device into consumer electronic devices. The use of USM-based storage cartridges will enable consumers and businesses to have instant access to their extensive data files, music, movies, photos, and other content from a variety of CE products in a seamless manner without the need for additional power or data cables. PC storage technology has advanced to the point where users can have nearly instantaneous access to the data and content stored on their computers, and the USM specification will provide the flexibility and portability required to extend that experience beyond the PC to consumer electronics devices, allowing users to truly share and enjoy their content wherever they go.

Based on SATA, the de facto interconnect standard in the storage industry, USM provides an easy method for OEMs to leverage the many benefits of SATA technology in a wide range of consumer electronics applications beyond traditional external PC storage. For example, USM provides power to storage devices while eliminating the cost and usage complexity associated with external cables. USM also supports the fastest transfer rates of any storage interface – up to 6 GB/s – with the same speed and reliability users have come to expect from SATA-based storage hard disk drives (HDD). In addition, USM is backwards compatible and gracefully degrades speed to support Gen 1 (1.5 GB/s) and Gen 2 (3 GB/s) drives. The flexibility of the USM standard also enables OEMs to introduce extended storage capabilities to existing applications without substantially increasing the Bill of Materials (BOM) cost, especially for devices which already support an internal SATA interface.

USM was designed to meet the storage needs of a variety of digital media applications, including:

- **PCs and Laptops:** USM cartridges simplify adding storage to PCs and laptops. They also enable the use of smaller density internal storage (like SSD), allowing laptops to be lighter and thinner with the larger capacity storage to reside on USM cartridges.
- **Digital Video Recorders (DVR)/Set-Top Boxes (STB):** Consumers can add additional capacity for storing more digital media content without service providers having to provide new equipment or pay for a truck roll.
- **TVs:** USM enables TVs to store content directly, eliminating the need for a separate DVR unit. In Japan, for example, 1/3 of TVs already have storage inside them. With the industry adopting “Smart TV” technology and DNLA compliancy, USM allows users to play their downloaded & user created content directly on the TV.





- **Game Consoles:** Game consoles employ a variety of storage configurations, including embedded HDDs, drives that can be upgradable by opening the system, and those which utilize a proprietary interface. USM enables console OEMs to lower initial system cost while giving users access to a wider variety of storage options.
- **Video Surveillance:** Video surveillance systems today use either internal hard drives or removable storage with limited capacity such as tape cartridges. USM provides for unlimited capacity and simple storage exchange to maximize recording time and flexibility.

Driving Down Storage Costs

One of the primary drivers for manufacturers adopting USM will be eliminating the costs associated with embedding fixed or upgradable storage within a device. The result will be increased inventory flexibility, more storage options for consumers, simplified certification, and lower system cost. Consider how storage is managed in digital cameras. The first digital cameras used embedded memory, which severely limited the capacity of cameras. By moving to external storage, manufacturers could eliminate the cost of storage from the initial purchase price of the camera, resulting in a more attractive price point. Consumers could also purchase the amount of storage they needed, as well as upgrade capacity whenever they wanted to. With USM, the same benefits can be extended to any CE device that needs embedded storage and can implement a USM cartridge slot.

From a manufacturer standpoint, USM provides many benefits, including the ability to introduce storage to a device without having to significantly increase the cost of the platform. For example, rather than having to estimate what the optimal “sweet spot” storage capacity will be when a product finally reaches market, engineers are able to design systems without storage as a constraint. HDDs become self-contained units with the PCB and connector integrated together, and one model is able to serve multiple applications with very different storage needs. Certification is also simplified: systems with embedded storage have to be redesigned and then recertified each time the internal storage capacity is changed. With USM, once manufacturers qualify the USM slot, system storage capacity can be upgraded without requalification. In addition, OEMs have a significantly reduced number of HDD SKUs to qualify since 1 SKU can support from 0 GB to 1 TB. Moving to external storage also shifts warranty cost – and risk – from OEMs to the HDD manufacturer.

From a retailer point of view, USM helps reduce inventory diversity while increasing consumer options. For example, instead of having to offer three similar devices that vary only by the amount of storage they offer, retailers can offer a single product with three USM cartridge options. This level of product consolidation when considered across multiple product lines not only reduces overall customer confusion when trying to determine which model to purchase, it frees up tremendous shelf space, gives retailers simple upsell options, and provides an opportunity for future upgrade revenues.





Service providers also benefit from USM through lower cost and increased customer satisfaction. Using external storage results in a lower initial outlay for DVRs and set-top boxes leading to an increase in profit per device. In addition, USM extends product lifecycles, reduces inventory size, simplifies equipment servicing, and eliminates the need for a service call to upgrade a customer's storage capacity. The availability of effectively endless storage will encourage sharing of digital media content throughout the home as well as enable access to video-on-demand (VOD) content services not previously supported by existing set-top boxes. Service providers will also experience reduced customer churn through their ability to provide a greater range of value options to their customers.

Enhancing the User Experience

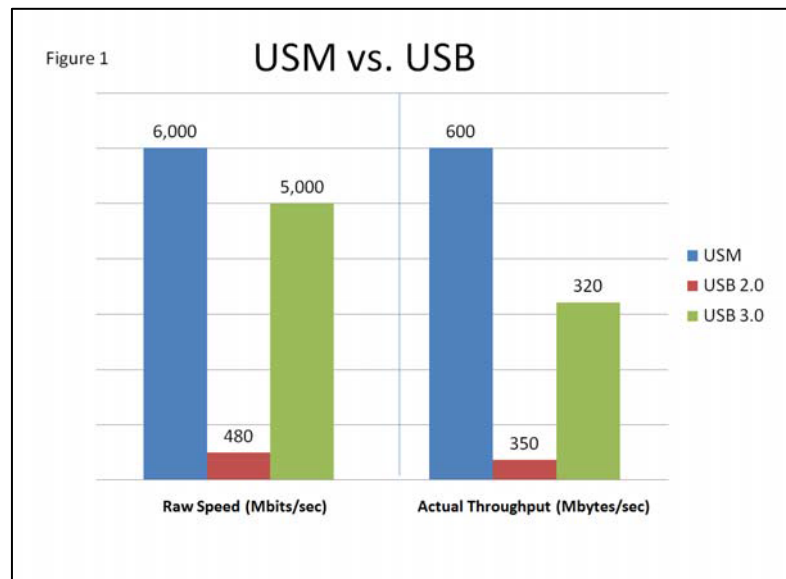
While USM offers cost savings and other benefits across the entire value chain, in the end, it is the consumer and business user who must be convinced to adopt the technology. USM provides a compelling value proposition by offering a wide range of benefits to end-users:

Highest Available Capacity: Proprietary storage interfaces will always be behind the speed and capacity curve. Consider that the highest capacity SD card available today provides only 64 GB of storage. SD technology is also very expensive; a 32 GB SD card costs about the same as a 500 GB hard drive. With USM, consumers will have access to significantly higher capacity at a much more affordable price.

Fastest Access: USM, as part of the SATA spec, supports the highest raw data rate for storage throughput at 6 GB/s. When effective throughput is taken into account, USM transfers data at 2X the speed of USB 3.0 (see Figure 1).

Universal Connectivity:

Through the use of simple bridging technology, a USM-based drive can connect to any device today using USB, FireWire, Thunderbolt, eSATA, HDMI, Wi-Fi, or other standard interconnect. For example, Seagate Technology's GoFlex interface cable connects to any USM cartridge and the storage will operate like an external hard drive. No other technology offers the flexibility of USM; for example, today an SD slot can only support SD-based cards. This





flexibility enables USM to serve as a universal storage connector as devices migrate from existing technology to native USM-based interfaces, allowing for an elegant transition as USM is adopted across various industries. As a result, USM-based devices will be able to connect across whatever interfaces become available in the future, making USM the universal storage interconnect.

Mobility of Content: Rather than being limited to what they can fit on their phone or portable media player, consumers can now carry all of their digital content – movies, music, and photos – with them wherever they go. In effect, consumers will be able to literally carry their computers in their pockets, from their data to their applications. It is also an efficient way to bring backup of critical data offsite.

Unrestricted Data Sharing: USM enables storage to be easily shared between all types of devices. For example, users will be able to remove a drive containing movies and music from their PC and plug it into their TV and watch their content within seconds without having to worry about issues with wireless connectivity.

Value: Users now have the ability to select the amount of storage they need to optimally match their use of digital media content. Consumers and businesses can also select storage capacity independent of device performance, enabling them to allocate their purchasing dollars where they will yield the most value.

Ease-of-Use: Consumers use USM cartridges simply by plugging them into a USM slot.

No More Cables: USM offers an elegant, cable-free approach to storage, eliminating consumer frustration from having forgotten to bring the right cable when using data remotely.

Easy Upgradability: The industrial design of USM is simple and easy to work with. Rather than having to open equipment enclosures to install more storage capacity, users can do so with a self-contained drive they can purchase from any electronics store. For systems like set-top boxes, upgrades can be performed by customers in their home or business without requiring a service technician visit.

Stable Interconnect: Since USM is based on the storage industry standard SATA, consumers and businesses will be able to use USM-based storage for years to come. Compare this to USB 2.0-based devices which cannot take advantage of USB 3.0 speeds and so are quickly becoming obsolete.

Ruggedness: With an insertion rate more than 10X that of USB [confirm: using 1500 times for USM, 130 for USB], the USM slot was designed to be robust and meet the demanding requirements needed to provide reliable operation within the consumer electronics industry.

Extended CE Product Life: The lifetime of a digital appliance like a TV or DVR is not congruent with the lifetime of storage. For example, consumers expect a TV to last at least a decade. In ten years, however, the 500 GB drive that came with a top-of-the-line TV will be





insufficient to support the future digital media needs of consumers as technologies like HDTV, Blu-Ray, and VOD increase storage requirements. By separating storage from the application platform, USM enables consumers to upgrade storage capacity to match the evolving digital landscape without having to continuously replace expensive equipment.

Wide Availability: Consumer electronics stores like Fry's, Best Buy, and Staples already carry SATA-based storage products. Because USM is part of the SATA standard and already shipping from vendors, it will be available to consumers off-the-shelf at these stores as well.

Implementing USM

USM has been designed to facilitate adoption throughout the diverse variety of industries in which removable storage is important. USM is an open standard without license fees that every OEM/ODM can adopt, so there are fewer barriers to entry compared to other interconnect standards. USM also leverages the proven and reliable technology of the existing SATA standard so there is nothing new for developers to learn beyond the connector form factor in order to support external storage. In cases where systems already have a SATA drive, introducing USM-based storage is as simple as implementing the new connector.

In terms of physical design, there are just a few connector differences to the standard SATA connector specification. The throat length has been extended and springs have been added to create a balanced connection that is firm and solid yet simple to detach. The connector also has an Electrostatic Discharge (ESD) shield for protection, as well as supports a higher insertion rating to improve reliability. Adding a USM slot to a device can be as low as \$2 USD, depending upon the application and casing materials.

By defining a standard physical size for cartridges, the USM spec provides OEMs with a clear form factor that offers smooth insertion and ensures interoperability of cartridges and slots. Defining a uniform size for cartridges allows the SATA connector to always be accurately positioned and connected for reliable operation while simplifying the insertion process for consumers. OEMs also have the flexibility to implement slots according to the orientation and implementation that best suits their application. This allows OEMs to accommodate different price points while still ensuring interoperability.

In general, the slot and connector to accept a USM cartridge can take one of three base designs. For low-cost applications, a half-slot can be used, leaving the cartridge sticking out part way and making it easy to remove the cartridge. For applications where a flush form factor is important, the entire cartridge can slide into the device. At the edge of the device, the slot needs to be a bit wider than the cartridge to allow a user to grip the cartridge from either side and remove it. A flush slot provides better aesthetics but requires that the receiving device be larger to accommodate the larger slot, potentially leading to higher cost as well. For high-end applications, an ejection mechanism can be used which allows the slot to match the cartridge size.



Migrating to External Storage

Device developers will need to consider several factors when migrating designs from internal to external storage. For example, the slot form factor and USM cartridge can affect the flow of air, imposing different thermal dynamics. Devices which do not have a cooling fan may need to implement passive cooling techniques within the enclosure. Some applications may require specific placement of the slot, such as on the bottom edge for a TV. Developers will also need to take physical shock protection into account since shock considerations differ between external and embedded drives. External connectors also expose a system to electrostatic discharge (ESD). However, since ESD protection is part of the USM form factor specification, developers do not need to take any additional precautions.

From a software perspective, developers may need to adjust drivers to account for the ability of USM cartridges to be removed and attached while a device is in operation. For example, with an embedded drive, there is no need for the system to recover from removal of the drive. Many of the use cases for USM, however, must support cartridge removal. The most extreme case, for example, is when the USM drive is also the boot drive and the system must be able to recover from the removal of the drive during start up. Alternatively, developers can avoid this issue by using USM only with secondary storage.

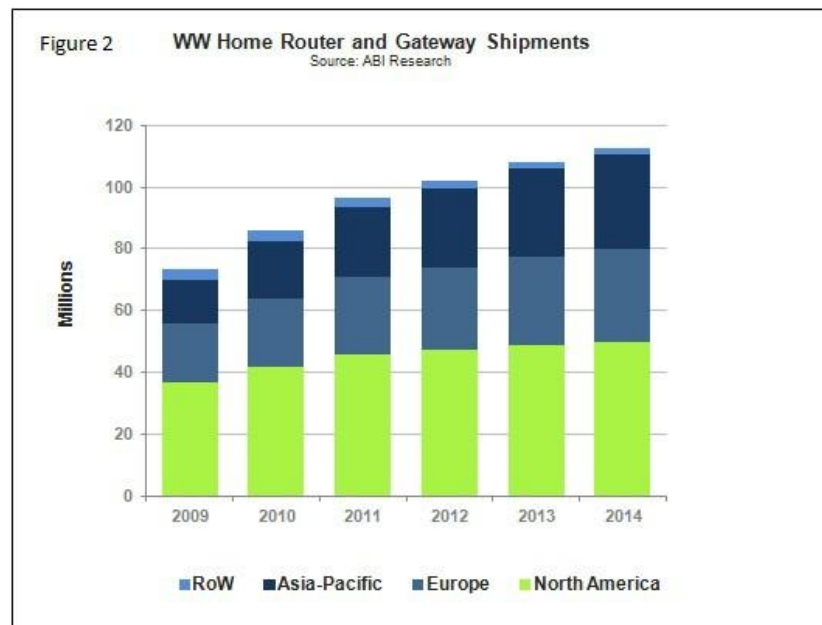
A more common cartridge removal case is when the USM drive is being bridged through another interface such as USB. Consider an application like a TV where the main processor does not natively support SATA but does have a USB port. With this architecture, the USM port is bridged to USB, and the USM drive now appears as a USB drive to the system. However, SATA does not respond to removal and attachment in the same manner as USB. Developers will need to adjust the system driver to gracefully handle unexpected removal and attachment of the USM drive.

There are applications that will still require some embedded storage, and such applications must be able to support some level of operation without external storage attached. With USM, manufacturers are able to adopt a system architecture that provides embedded storage with the capacity to extend storage capacity in a cost-effective way. For example, instead of embedding a 500 GB drive in a system, a manufacturer could install a smaller 250 GB or 320 GB drive and allow the user to upgrade to more capacity if desired.

Note that manufacturers always have the option of shipping fixed storage installed in a device (i.e., they want to give consumers the impression that storage is internal to the device or that the device is self-contained). With this approach, storage can be added as the final manufacturing step or as part of a value added reseller (VAR) soft bundling option since the storage cartridge can be installed after the system has been completely put together. Not only does this reduce overall inventory, it gives manufacturers the flexibility to quickly adjust device storage capacity to meet changing market needs and demands.

Overall, USM will enable manufacturers and retailers to offer products at a lower cost; since storage no longer needs to be embedded in the device, the base device cost can be reduced appropriately. Given that a HDD is often one of the most expensive components in a system, this reduction is substantial. Granted, while embedded storage is typically less expensive than external storage because it does not require a robust case, the numerous benefits manufacturers, retailers, and end-users gain from USM results in a lower total cost of ownership.

As with any new standard, there is always some concern about whether product will be available if OEMs implement the interface for it. In the case of USM, USM-based products are already available from a variety of vendors, including Antec, GIEC, HiSense, Ionics, Lenuss, Mele, Seagate Technology, and Thermaltake. For example, storage companies like Seagate are already producing USM cartridges; there are currently more than 10 million cartridges on the market with an anticipated 20 million by the end of 2011. Thus the market is already being seeded with USM-based storage, creating demand for native USM



slots in all types of digital devices as the demand for home-based network attached storage (NAS) increases (see Figure 2). Risk is also reduced for OEMs since the bridging capabilities of USM allow consumers to use existing storage based on USB, FireWire, and other interconnect technologies, thus smoothing the transition to USM.

USM brings many cost and ease-of-use capabilities to end-users as well as manufacturers, retailers, and service providers. The implementation is designed to enable the easy addition of removable and expandable storage to any CE device. USM-based devices not only allow consumers and businesses to carry their entire digital media content library and all of their other data with them, it also simplifies the organization, management, and sharing of data for every application. The flexibility and interoperability of USM is unmatched by any other interconnect standard, providing end-users with legacy support and a smooth transition as CE devices migrate to native USM slots. By separating storage from the application platform, end-users have the freedom to pay for only the capacity they want, when they need it.



To learn more about the SATA-IO and its nearly 200 participating companies, visit <https://www.sata-io.org/>. Information on the USM specification and related products can be found at <http://www.serialata.org/technology/usm.asp>. Specific details on the size requirements for USM devices and CE slots have been developed by the Small Form Factor Committee and are available at www.SITE.org.

